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# EFFECT OF SKIPS, OR MISSING ROW SEGMENTS, ON YIELD OF SEED COTTON IN FIELD EXPERIMENTS[1]

By O. A. POPE[2]

*Agronomist, Division of Cotton and Other Fiber Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture*

## INTRODUCTION

The effect of skips, or missing segments of row, on yield constitutes an important problem in research as well as in commercial cotton production. In field experimental work a perfect stand seldom survives, and consequently the research worker is frequently confronted with the problem of making adjustments of single-plot yields in analyzing data from field trials. If the missing row segments are due to poor germination or to disease, it may be proper to penalize the variety or treatment containing the missing segment; but if skips are due to extravarietal causes, it is logical that yields be adjusted in order that comparisons among varieties or treatments may be made with the best precision possible in the circumstances.

In the commercial production of cotton (*Gossypium* spp.), stand difficulties of two types are frequently encountered: (1) Uniformly thin stands and (2) stands with skips.

Low-germinating seed, seedling diseases, or other causes may result in a thin but rather regular stand over the field, and studies on spacing and rate of planting have shown that thin stands may give satisfactory yields under average seasonal conditions. Extensive data summarized by Brown[3] and Reynolds[4] show that substantially equal yields of

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[2] The assistance of a number of research workers was invaluable in extending the study to include a range of environmental conditions sufficiently wide to be representative of those likely to be encountered in future field work. Their cooperation is gratefully acknowledged, and the courtesy of State experiment stations in providing facilities is appreciated. The individuals and respective experiment stations are J. B. Dick, Alabama Agricultural Experiment Station; C. J. King, U. S. Cotton Field Station, Sacaton, Ariz.; G. J. Harrison, U. S. Cotton Field Station, Shafter, Calif.; J. R. Cotton, Louisiana Agricultural Experiment Station; J. W. Neely, U. S. Cotton Field Station, Stoneville, Miss.; A. R. Leding, U. S. Cotton Field Station, State College, N. Mex.; R. H. Tilley, North Carolina Agricultural Experiment Station, Statesville, N. C.; L. L. Ligon, Oklahoma Agricultural Experiment Station; D. M. Simpson, U. S. Cotton Field Station, Knoxville, Tenn.; and D. R. Hooton, U. S. Cotton Field Station, Greenville, Tex.

[3] BROWN, H. B. COTTON SPACING. Miss. Agr. Expt. Sta. Bul. 212, 16 pp. 1923.

[4] REYNOLDS, E. B. THE EFFECT OF SPACING ON THE YIELD OF COTTON. Tex. Agr. Expt. Sta. Bul. 340, 77 pp., illus. 1926.

cotton may be expected within relatively wide spacing limits at individual locations representing the major sections of the main Cotton Belt. Studies by Ware,[5] made at Scott, Ark., indicated that total yield was substantially the same with stands ranging from approximately 15,000 to 75,000 plants per acre, when boll weevil damage was not severe.

Replanting is seldom carried out if the stand is uniformly thin; but if fields contain many rather long skips it is customary to replant the entire row or field. In this operation most or all of the earlier plants are destroyed; frequently it is difficult for the grower to determine whether replanting is likely to be profitable, and little experimental evidence is available as a guide in deciding on the advisability of replanting.

## EXPERIMENTAL PROCEDURE

As a consequence of the need for information on the effect of missing row segments on experimental procedure and in practical production, a series of experiments was arranged in 1936 to study this problem. The plan, used at nine locations in 1936 and 1937, at seven locations in 1938, and at two locations in 1939, consisted of a 10 by 10 Latin square including a perfect-stand check and artificial skips ranging from 2 to 10 feet in increments of 1 foot. Three-row plots 25 feet long were used throughout the study, and skips were made in the center row at the normal thinning date. The use of a uniform plot size and a similar plan at all locations greatly facilitated the statistical treatment of the data. Several of the cooperating stations obtained data for 3 years; but other stations were prevented from full participation by the fact that a perfect stand over the entire area was not obtained, and consequently the desired pattern of skips could not be produced. In most cases the skip-correction studies were carried out on multiplication blocks or general plantings, and for this reason different blocks of land were used in succeeding years at several of the stations. Different varieties or strains were used at various locations, and in some cases different strains were used in succeeding years at the same location. Combined analyses were not made either for single years or for the whole study, since year and place effects would have been confounded with variety or strain and also with experimental area within locations.

The questions of greatest practical importance are the effect of skips on total plot yield and the distribution of this effect among rows within the plot. The minimum amount of data satisfactory for analysis consisted of the yield of each plot by individual rows. In order that the distribution of effect of skips of different lengths within the plot might be determined, data were obtained on either boll counts or weight of seed cotton by row segments as indicated in the following plan:

| | *Left segments* | | | *Skip length* | *Right segments* | | |
|---|---|---|---|---|---|---|---|
| Row *a*, | 3–L | 2–L | 1–L | adjacent_ | 1–R | 2–R | 3–R |
| Row *b*, | 3–L | 2–L | 1–L | skip_____ | 1–R | 2–R | 3–R |
| Row *c*, | 3–L | 2–L | 1–L | adjacent_ | 1–R | 2–R | 3–R |

Within each plot the rows were designated *a*, *b*, and *c*. In each of the outside rows *a* and *c* a section opposite the skip and of the same

[5] WARE, J. O. COTTON SPACING. I. STUDIES OF THE EFFECT ON YIELD AND EARLINESS. Ark. Agr. Expt. Sta. Bul. 230, 84 pp. 1929.

length as the skip was designated "adjacent." Within each row the two sections contiguous to the skip of row *b* or to the adjacent parts of the outside rows were designated for the segment studies as 1–L, 2–L, or 3–L (left) and 1–R, 2–R, or 3–R (right). Each L or R segment was 3 feet long. Data on boll counts or seed-cotton weights for the various segments were recorded in the proper location on plot sketches. In most tables reporting of only two decimal places for mean actual yields and of only one for mean percentage yields seemed sufficient to show differences.

## EXPERIMENTAL RESULTS

Data from the skip-correction study consisted of yield of seed cotton by single rows and boll counts or weights on the "adjacent" and 3-foot segments outlined in the plot plan previously discussed.

### YIELD ON TOTAL PLOT

Total-plot yields, in pounds of seed cotton, for the 9 participating locations in 1936, are summarized in the first 11 columns of table 1. Plot size was the same throughout the study, but variations in average yield were rather wide as is evident from the range in station means, 1.23 to 15.35 pounds. It is noticeable, however, that the yields for various skip lengths within any location tend to be consistent, and there was no marked reduction in yield with increasing skip length at any single location or in the average for all locations.

Because of wide differences in average yield among stations, it seemed desirable to convert actual yield to a percentage of each station average for ease in comparing tests. The percentage yields for each station are shown in the last 10 columns of table 1, and these confirm the actual yields in showing that there was no marked reduction in yield with increasing skip length. The averages of all stations indicate that in 1936 there was a slight tendency for the longer skips to produce smaller yields; but it will be noted that the 10-foot skip was accompanied by only a small reduction in yield, although it represented a 13.3-percent reduction in the area of the plot.

Summaries of the yields of seed cotton for whole plots in the 1937, 1938, and 1939 studies also are shown in table 1. These studies, which included data from some additional stations and from some of the same stations in succeeding years, confirmed the findings in 1936 that skips in an interior row of a multiple-row plot have little effect on total yield of the plot. A tendency for a slight reduction in yield on the plots having greater skip lengths is evident in the averages for all stations in each of the years. The proportionate decrease in yield with increasing skip length is not consistent at all stations and not significant in any of the 27 tests included in the study.

Analyses of variance, according to the methods developed by Fisher,[6] were made on whole-plot yields for each location in each year, and a summary of these analyses is shown in table 2. Wide differences were found in mean squares for total variance and for the variance due to columns, rows, and error, and these findings reflect the hetero-

[6] FISHER, R. A. STATISTICAL METHODS FOR RESEARCH WORKERS. Ed. 6, rev. and enl., 339 pp., illus. London. 1936.

TABLE 1.—*Total yields of seed cotton at various locations, 1936–39*

| Year and location | Pounds per plot with indicated skip length (feet) | | | | | | | | | | | Percentage of station average yield with indicated skip length (feet) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | 0 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| *1936* | | | | | | | | | | | | | | | | | | | | | |
| Alabama | 2.73 | 3.08 | 3.10 | 2.81 | 2.85 | 2.79 | 2.89 | 2.72 | 2.68 | 2.65 | 2.83 | 96.5 | 108.8 | 109.6 | 99.4 | 100.5 | 98.6 | 102.0 | 96.0 | 94.8 | 93.7 |
| California | 15.73 | 15.65 | 15.18 | 15.52 | 14.10 | 15.76 | 15.99 | 14.50 | 15.80 | 15.30 | 15.35 | 102.5 | 101.9 | 98.9 | 101.1 | 91.8 | 102.6 | 104.1 | 94.4 | 102 9 | 99.6 |
| Louisiana | 7.22 | 7.24 | 7.08 | 7.79 | 6.87 | 7.48 | 7.10 | 6.90 | 7.22 | 6.75 | 7.17 | 100.8 | 101.1 | 98.8 | 108.7 | 95.9 | 104.4 | 99.1 | 96.3 | 100.7 | 94.2 |
| Mississippi | 7.89 | 6.94 | 7.28 | 7.01 | 6.92 | 6.63 | 7.43 | 7.46 | 7.54 | 6.76 | 7.19 | 109.8 | 96.6 | 101.3 | 97.5 | 96.3 | 92.3 | 103.4 | 103.8 | 104.9 | 94.1 |
| New Mexico | 10.32 | 10.66 | 10.68 | 9.67 | 10.09 | 10.27 | 10.24 | 9.91 | 9.93 | 9.84 | 10.16 | 101.6 | 104.9 | 105.1 | 95.2 | 99.3 | 101.1 | 100.8 | 97.5 | 97.7 | 96.8 |
| North Carolina | 5.14 | 5.15 | 5.30 | 5.09 | 4.99 | 5.29 | 5.17 | 5.15 | 5.12 | 5.24 | 5.16 | 99.5 | 99.8 | 102.6 | 98.6 | 96.5 | 102.4 | 100.1 | 99.6 | 99.1 | 101.5 |
| Oklahoma | 1.30 | 1.23 | 1.22 | 1.20 | 1.25 | 1.26 | 1.24 | 1.19 | 1.19 | 1.19 | 1.23 | 105.5 | 100.3 | 99.5 | 97.6 | 102.0 | 102.8 | 100.8 | 96.9 | 97.2 | 97.3 |
| Tennessee | 7.94 | 8.21 | 8.45 | 8.15 | 8.20 | 8.00 | 8.25 | 7.73 | 8.15 | 8.03 | 8.11 | 97.9 | 101.2 | 104.3 | 100.5 | 101.1 | 98.6 | 101.7 | 95.3 | 100.4 | 99.0 |
| Texas | 4.34 | 4.28 | 4.12 | 4.34 | 4.17 | 4.08 | 4.21 | 4.21 | 4.25 | 4.06 | 4.21 | 103.2 | 101.8 | 98.0 | 103.2 | 99.1 | 97.0 | 100.1 | 100.1 | 101.0 | 96.5 |
| Average | 6.96 | 6.94 | 6.94 | 6.84 | 6.60 | 6.84 | 6.95 | 6.64 | 6.88 | 6.65 | 6.82 | 101.9 | 101.7 | 101.7 | 100.3 | 96.8 | 100.2 | 101.8 | 97.3 | 100.8 | 97.4 |
| *1937* | | | | | | | | | | | | | | | | | | | | | |
| Arizona (Mesa) | 10.85 | 11.02 | 11.65 | 10.73 | 11.19 | 10.73 | 10.96 | 10.29 | 10.29 | 11.15 | 10.87 | 99.7 | 101.2 | 107.0 | 98.6 | 102.8 | 98.6 | 100.7 | 94.5 | 94.5 | 102.4 |
| Arizona (Sacaton) | 10.96 | 11.54 | 11.49 | 11.57 | 11.31 | 10.63 | 10.01 | 11.82 | 10.87 | 10.33 | 11.05 | 99.2 | 104.4 | 103 9 | 104.7 | 102.3 | 96.2 | 90.6 | 106.9 | 98.3 | 93.5 |
| California | 18.31 | 18.51 | 18.52 | 17.79 | 17.86 | 16.77 | 18.14 | 19.08 | 17.84 | 17.60 | 18.04 | 101.5 | 102.6 | 102.6 | 98.6 | 99.0 | 92.9 | 100.5 | 105.7 | 98.9 | 97.5 |
| Louisiana | 11.77 | 12.34 | 11.51 | 11.82 | 12.33 | 12.18 | 11.52 | 11.28 | 11.64 | 11.50 | 11.79 | 99.8 | 104.7 | 97.7 | 100.2 | 104.6 | 103.3 | 97.7 | 95.7 | 98.7 | 97.6 |
| Mississippi | 11.44 | 12.27 | 12.09 | 12.46 | 11.86 | 11.56 | 11.77 | 11.65 | 11.72 | 11.74 | 11.86 | 96.5 | 103.5 | 101.9 | 105.0 | 100.0 | 97.4 | 99.2 | 98.2 | 98.8 | 99.0 |
| North Carolina | 8.69 | 8.85 | 8.90 | 8.59 | 8.46 | 9.39 | 8.53 | 8.54 | 8.23 | 8.11 | 8.63 | 100.8 | 102.6 | 103.1 | 99.5 | 98.0 | 108.8 | 98.8 | 99.0 | 95.4 | 94.0 |
| Oklahoma | 2.71 | 2.61 | 2.68 | 2.46 | 2.68 | 2.81 | 2.60 | 2.64 | 2.68 | 2.67 | 2.65 | 102.2 | 98.4 | 100.9 | 92.6 | 100.9 | 105.8 | 97.9 | 99.6 | 101.2 | 100.5 |
| Tennessee | 4.68 | 4.73 | 4.78 | 4.97 | 4.85 | 4.74 | 4.68 | 4.82 | 4.63 | 4.57 | 4.75 | 98.6 | 99.6 | 100.8 | 104.7 | 102.2 | 99.9 | 98.5 | 101.6 | 97.6 | 96.4 |
| Texas | 4.89 | 4.88 | 4.72 | 4.91 | 4.77 | 4.76 | 4.91 | 4.81 | 4.71 | 4.90 | 4.83 | 101.3 | 101.1 | 97.8 | 101.7 | 98.8 | 98.6 | 101.7 | 99.7 | 97.6 | 101.5 |
| Average | 9.37 | 9.64 | 9.59 | 9.48 | 9.48 | 9.28 | 9.23 | 9.44 | 9.18 | 9.17 | 9.38 | 99.8 | 101.9 | 101.7 | 100.6 | 100.9 | 100.1 | 98.3 | 100.0 | 97.8 | 98.0 |
| *1938* | | | | | | | | | | | | | | | | | | | | | |
| Arizona (Mesa) | 12.71 | 12.79 | 13.02 | 12.44 | 12.61 | 12.54 | 12.10 | 12.32 | 11.86 | 12.26 | 12.46 | 102.0 | 102.6 | 104.4 | 99.8 | 101.2 | 100.6 | 97.1 | 98.8 | 95.1 | 98.4 |
| Arizona (Sacaton) | 12.17 | 12.17 | 12.16 | 11.33 | 12.19 | 11.73 | 11.14 | 11.11 | 11.54 | 12.10 | 11.76 | 103.5 | 103.5 | 103.3 | 96.3 | 103.6 | 99.7 | 94.7 | 94.5 | 98.1 | 102.8 |
| California | 14.62 | 15.38 | 14.45 | 15.09 | 15.18 | 14.84 | 14.90 | 14.32 | 14.20 | 14.80 | 14.78 | 98.9 | 104.1 | 97.8 | 102.1 | 102.7 | 100.4 | 100.8 | 96.9 | 96.1 | 100.1 |
| Mississippi | 10.07 | 9.80 | 9.74 | 9.86 | 9.89 | 9.47 | 9.89 | 9.86 | 9.85 | 10.00 | 9.84 | 102.3 | 99.6 | 99.0 | 100.2 | 100.5 | 96.2 | 100.5 | 100.2 | 100.1 | 101.6 |
| North Carolina | 7.91 | 7.93 | 7.61 | 7.84 | 8.04 | 7.81 | 7.34 | 7.88 | 7.78 | 7.76 | 7.79 | 101.5 | 101.8 | 97.7 | 100.6 | 103.2 | 100.2 | 94.3 | 101.2 | 99.9 | 99.6 |
| Tennessee | 4.00 | 4.23 | 3.96 | 4.40 | 4.35 | 4.20 | 3.89 | 4.31 | 4.35 | 3.92 | 4.16 | 96.2 | 101.6 | 95.2 | 105.9 | 104.6 | 100.9 | 93.4 | 103.5 | 104.5 | 94.3 |
| Texas | 4.74 | 4.58 | 4.93 | 4.54 | 4.87 | 4.73 | 4.36 | 4.47 | 4.47 | 4.33 | 4.60 | 103.0 | 99.5 | 107.1 | 98.6 | 105.8 | 102.8 | 94.7 | 97.1 | 97.1 | 94.1 |
| Average | 9.46 | 9.55 | 9.41 | 9.36 | 9.59 | 9.33 | 9.09 | 9.18 | 9.15 | 9.31 | 9.34 | 101.1 | 101.8 | 100.6 | 100.5 | 103.1 | 100.1 | 96.5 | 98.9 | 98.7 | 98.7 |
| *1939* | | | | | | | | | | | | | | | | | | | | | |
| Arizona (Mesa) | 14.70 | 14.48 | 14.77 | 14.65 | 14.58 | 13.91 | 14.15 | 14.09 | 14.19 | 14.19 | 14.37 | 102.3 | 100.8 | 102.8 | 101.9 | 101.4 | 96.8 | 98.5 | 98.0 | 98.7 | 98.7 |
| New Mexico | 13.89 | 13.74 | 13.33 | 13.12 | 13.70 | 12.71 | 13.53 | 13.12 | 13.43 | 13.55 | 13.41 | 103.6 | 102.4 | 99.4 | 97.8 | 102.1 | 94.8 | 100.9 | 97.8 | 100.1 | 101.0 |
| Average | 14.29 | 14.11 | 14.05 | 13.88 | 14.14 | 13.31 | 13.84 | 13.60 | 13.81 | 13.87 | 13.89 | 102.9 | 101.6 | 101.1 | 99.9 | 101.8 | 95.8 | 99.7 | 97.9 | 99.4 | 99.9 |
| Average, 1936–39 | 8.95 | 9.05 | 8.99 | 8.89 | 8.89 | 8.78 | 8.78 | 8.75 | 8.75 | 8.71 | 8.85 | 101.1 | 102.2 | 101.5 | 100.5 | 100.5 | 99.2 | 99.1 | 98.8 | 98.8 | 98.4 |

geneity of plant response due to location and among individual plots within each experimental block. The one consistent and important result of these analyses is that the contribution for skips was not significantly different from error in any of the 27 tests. The conclusion that skip lengths of as much as 10 feet in an interior row of a multiple-row plot have no significant effect on total-plot yield seems to be well substantiated.

TABLE 2.—*Analyses of variance for total yield of seed cotton in table 1*

| Year and location | Mean squares [1] | | | | |
|---|---|---|---|---|---|
| | Total | Columns | Rows | Skips | Error |
| *1936* | | | | | |
| Alabama | 0.2778 | 0.9306 | 0.6811 | 0.2409 | 0.1504 |
| California | 17.5835 | 128.3349 | 38.6971 | 3.7331 | 2.8317 |
| Louisiana | 1.8092 | 13.2777 | .6330 | .9383 | .6315 |
| Mississippi | 1.7655 | 2.2920 | 8.8943 | 1.5747 | .8324 |
| New Mexico | 2.5127 | 3.0270 | 16.6183 | 1.1414 | .8566 |
| North Carolina | .6196 | 1.7041 | 2.3645 | .0901 | .3320 |
| Oklahoma | .0195 | .0149 | .0697 | .0122 | .0147 |
| Tennessee | 2.8019 | 23.4720 | 3.2158 | .3976 | .4670 |
| Texas | .1927 | .8149 | .3100 | .0992 | .1119 |
| *1937* | | | | | |
| Arizona (Mesa) | 2.5269 | 12.3358 | 1.3472 | 1.6996 | 1.5516 |
| Arizona (Sacaton) | 6.8888 | 12.6771 | 31.7891 | 3.5349 | 3.4719 |
| California | 3.2711 | 9.1359 | 3.4182 | 3.9524 | 2.4345 |
| Louisiana | 2.6541 | 8.9535 | 5.8539 | 1.4061 | 1.6226 |
| Mississippi | 2.9732 | 18.8689 | 2.4514 | 1.0372 | 1.2935 |
| North Carolina | 1.6741 | 10.4184 | 1.6187 | 1.3062 | .6339 |
| Oklahoma | .2021 | .6593 | .4755 | .0803 | .1260 |
| Tennessee | .7170 | .9523 | 3.5669 | .1369 | .4042 |
| Texas | .1413 | .2865 | .4532 | .0656 | .0937 |
| *1938* | | | | | |
| Arizona (Mesa) | 1.1530 | 4.1192 | 1.3016 | 1.1814 | .7001 |
| Arizona (Sacaton) | 1.9125 | 2.1033 | | 1.4194 | 1.9734 |
| California | 3.3159 | 10.8326 | 3.9615 | 1.4633 | 2.5271 |
| Mississippi | .9283 | 3.1698 | 2.6962 | .2587 | .5109 |
| North Carolina | .4721 | .8662 | 1.0469 | .3788 | .3626 |
| Tennessee | .4969 | 1.0811 | 1.5364 | .3944 | .3068 |
| Texas | .2244 | .1735 | .9675 | .4295 | .1123 |
| *1939* | | | | | |
| Arizona (Mesa) | 1.6003 | 8.4939 | 4.1116 | .8963 | .5126 |
| New Mexico | 1.2655 | 6.9617 | 1.0435 | 1.2471 | .5835 |

[1] Degrees of freedom: 99 for total; 9 for columns, rows, and skips; and 72 for error.

YIELD ON MIDDLE ROW

A summary of the yields of seed cotton on middle rows for the 9 locations in 1936 is shown in the first 11 figure columns of table 3. The general level of yields varied widely among locations, the station averages ranging from 0.36 to 4.44 pounds. In order that comparisons might be made more easily, actual yields were converted to percentages of each station average, and these means are tabulated for each station in the last 10 columns of table 3. On either the actual or the percentage basis, there is a substantially linear decrease in yield of seed cotton with increasing skip lengths for each test and for the average of all locations. The tendency for reduction in yield appears to be reasonably consistent despite wide differences in general level of yield. The extremely low yields in Oklahoma are a result of severe drought, but the decrease in yield on middle row for increasing skip lengths at this station was reasonably consistent with other localities in the rain belt and also with the 2 stations, California and New Mexico, where cotton was produced under irrigation. This consistency in behavior suggests that the trends exhibited represent a general

TABLE 3.—*Yields of seed cotton on middle rows at various locations, 1936–39*

| Year and location | Pounds per middle row with indicated skip length (feet) | | | | | | | | | | | Percentage of station average yield of middle row with indicated skip length (feet) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | 0 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| *1936* | | | | | | | | | | | | | | | | | | | | | |
| Alabama | 0.86 | 0.96 | 0.98 | 0.88 | 0.87 | 0.85 | 0.79 | 0.70 | 0.72 | 0.63 | 0.83 | 104.0 | 116.8 | 119.2 | 107.1 | 105.6 | 102.9 | 95.7 | 85.3 | 86.9 | 76.4 |
| California | 5.12 | 5.11 | 4.81 | 4.70 | 4.21 | 4.43 | 4.55 | 3.81 | 3.99 | 3.64 | 4.44 | 115.4 | 115.2 | 108.4 | 105.9 | 94.9 | 99.8 | 102.5 | 85.9 | 89.9 | 82.0 |
| Louisiana | 2.43 | 2.40 | 2.35 | 2.51 | 2.16 | 2.39 | 2.13 | 1.98 | 2.07 | 1.82 | 2.22 | 109.3 | 107.9 | 105.5 | 112.8 | 97.1 | 107.5 | 95.6 | 89.2 | 93.1 | 81.8 |
| Mississippi | 2.69 | 2.22 | 2.38 | 2.37 | 2.18 | 2.01 | 2.21 | 2.18 | 2.18 | 1.86 | 2.23 | 120.7 | 99.6 | 106.8 | 106.4 | 97.8 | 90.2 | 99.2 | 97.8 | 97.8 | 83.5 |
| New Mexico | 3.54 | 3.59 | 3.50 | 3.01 | 3.02 | 2.94 | 2.64 | 2.58 | 2.47 | 2.17 | 2.95 | 120.2 | 121.9 | 118.8 | 102.2 | 102.5 | 99.8 | 89.6 | 87.6 | 83.8 | 73.7 |
| North Carolina | 1.68 | 1.87 | 1.75 | 1.66 | 1.45 | 1.62 | 1.49 | 1.40 | 1.33 | 1.33 | 1.56 | 107.6 | 120.0 | 112.2 | 106.4 | 93.0 | 104.0 | 95.9 | 90.2 | 85.4 | 85.2 |
| Oklahoma | .44 | .38 | .40 | .36 | .40 | .36 | .33 | .31 | .30 | .29 | .36 | 122.2 | 106.5 | 112.1 | 99.5 | 113.2 | 100.9 | 93.4 | 88.1 | 83.9 | 80.2 |
| Tennessee | 2.68 | 2.72 | 2.78 | 2.69 | 2.54 | 2.31 | 2.39 | 2.16 | 2.23 | 2.10 | 2.46 | 109.0 | 110.7 | 113.0 | 109.4 | 103.1 | 94.1 | 96.9 | 87.8 | 90.6 | 85.4 |
| Texas | 1.42 | 1.35 | 1.27 | 1.32 | 1.29 | 1.24 | 1.21 | 1.13 | 1.12 | 1.09 | 1.24 | 114.1 | 108.5 | 102.1 | 106.1 | 103.7 | 99.7 | 97.3 | 90.8 | 90.0 | 87.6 |
| Average | 2.32 | 2.29 | 2.25 | 2.17 | 2.01 | 2.02 | 1.97 | 1.81 | 1.82 | 1.66 | 2.03 | 114.1 | 112.7 | 110.6 | 106.7 | 99.1 | 99.3 | 97.0 | 89.0 | 89.8 | 81.6 |
| *1937* | | | | | | | | | | | | | | | | | | | | | |
| Arizona (Mesa) | 3.76 | 3.79 | 3.69 | 3.46 | 3.19 | 3.17 | 3.22 | 2.66 | 2.47 | 2.71 | 3.21 | 117.1 | 118.0 | 114.9 | 107.7 | 99.3 | 98.7 | 100.2 | 82.8 | 76.9 | 84.4 |
| Arizona (Sacaton) | 3.63 | 3.55 | 3.58 | 3.70 | 3.59 | 2.92 | 2.87 | 3.10 | 2.62 | 2.51 | 3.21 | 113.2 | 110.7 | 111.6 | 115.4 | 111.9 | 91.0 | 89.5 | 96.7 | 81.7 | 78.3 |
| California | 5.98 | 5.97 | 5.99 | 5.42 | 5.31 | 4.85 | 4.89 | 4.91 | 4.35 | 4.03 | 5.17 | 115.7 | 115.5 | 115.9 | 104.8 | 102.7 | 93.8 | 94.6 | 95.0 | 84.1 | 77.9 |
| Louisiana | 3.91 | 4.22 | 3.72 | 3.95 | 4.00 | 3.78 | 3.64 | 3.42 | 3.40 | 3.30 | 3.73 | 104.7 | 113.0 | 99.5 | 105.7 | 107.2 | 101.2 | 97.5 | 91.6 | 91.1 | 88.5 |
| Mississippi | 3.77 | 3.96 | 3.97 | 3.95 | 3.86 | 3.56 | 3.48 | 3.52 | 2.97 | 3.13 | 3.62 | 104.2 | 109.5 | 109.8 | 109.2 | 106.7 | 98.4 | 96.2 | 97.3 | 82.1 | 86.5 |
| North Carolina | 2.94 | 2.79 | 2.89 | 2.82 | 2.57 | 2.81 | 2.36 | 2.39 | 2.20 | 2.09 | 2.59 | 113.6 | 108.0 | 111.7 | 108.9 | 99.2 | 108.8 | 91.2 | 92.5 | 85.3 | 80.9 |
| Oklahoma | .95 | .83 | .96 | .76 | .80 | .81 | .76 | .73 | .68 | .68 | .80 | 119.8 | 104.3 | 120.4 | 95.7 | 100.5 | 101.9 | 94.9 | 91.7 | 85.9 | 84.8 |
| Tennessee | 1.62 | 1.58 | 1.46 | 1.65 | 1.45 | 1.35 | 1.25 | 1.32 | 1.17 | 1.18 | 1.40 | 115.6 | 112.5 | 104.3 | 117.3 | 103.5 | 96.1 | 89.3 | 94.0 | 83.0 | 84.3 |
| Texas | 1.70 | 1.62 | 1.57 | 1.59 | 1.47 | 1.41 | 1.37 | 1.36 | 1.26 | 1.27 | 1.46 | 116.3 | 110.8 | 107.4 | 108.8 | 100.5 | 96.4 | 93.7 | 93.0 | 86.2 | 86.9 |
| Average | 3.14 | 3.15 | 3.09 | 3.03 | 2.92 | 2.74 | 2.65 | 2.60 | 2.35 | 2.32 | 2.80 | 113.4 | 111.4 | 110.6 | 108.2 | 103.5 | 98.5 | 94.1 | 92.7 | 84.0 | 83.6 |
| *1938* | | | | | | | | | | | | | | | | | | | | | |
| Arizona (Mesa) | 4.36 | 4.19 | 4.21 | 3.92 | 3.83 | 3.66 | 3.54 | 3.33 | 3.01 | 3.21 | 3.73 | 117.0 | 112.4 | 113.0 | 105.2 | 102.8 | 98.2 | 95.0 | 89.4 | 80.8 | 86.1 |
| Arizona (Sacaton) | 4.21 | 4.46 | 4.39 | 3.93 | 4.00 | 3.76 | 3.54 | 3.36 | 3.44 | 3.31 | 3.84 | 109.7 | 116.1 | 114.2 | 102.3 | 104.2 | 97.8 | 92.3 | 87.4 | 89.7 | 86.3 |
| California | 4.92 | 5.06 | 4.68 | 4.66 | 4.66 | 4.51 | 4.14 | 4.01 | 3.83 | 3.70 | 4.42 | 111.4 | 114.6 | 105.9 | 105.5 | 105.5 | 102.1 | 93.7 | 90.8 | 86.7 | 83.8 |
| Mississippi | 3.39 | 3.16 | 3.21 | 3.36 | 3.37 | 3.10 | 3.10 | 2.96 | 2.70 | 2.72 | 3.11 | 109.1 | 101.7 | 103.3 | 108.1 | 108.5 | 99.8 | 99.8 | 95.3 | 86.9 | 87.5 |
| North Carolina | 2.61 | 2.69 | 2.53 | 2.52 | 2.52 | 2.28 | 2.14 | 2.11 | 2.19 | 2.04 | 2.36 | 110.3 | 113.7 | 107.1 | 106.7 | 106.8 | 96.7 | 90.4 | 89.5 | 92.6 | 86.2 |
| Tennessee | 1.48 | 1.50 | 1.33 | 1.32 | 1.38 | 1.19 | 1.13 | 1.23 | 1.17 | 1.08 | 1.28 | 115.2 | 117.0 | 103.9 | 103.1 | 107.6 | 93.3 | 88.3 | 95.9 | 91.7 | 84.1 |
| Texas | 1.56 | 1.53 | 1.54 | 1.44 | 1.50 | 1.37 | 1.20 | 1.22 | 1.17 | 1.05 | 1.36 | 114.9 | 112.7 | 113.4 | 106.0 | 110.5 | 100.9 | 88.4 | 89.8 | 86.2 | 77.3 |
| Average | 3.22 | 3.23 | 3.13 | 3.02 | 3.04 | 2.84 | 2.68 | 2.60 | 2.50 | 2.44 | 2.87 | 112.5 | 112.6 | 108.7 | 105.3 | 106.5 | 98.4 | 92.5 | 91.1 | 87.8 | 84.5 |
| *1939* | | | | | | | | | | | | | | | | | | | | | |
| Arizona (Mesa) | 4.96 | 4.92 | 4.92 | 4.73 | 4.51 | 4.20 | 4.18 | 3.78 | 3.82 | 3.79 | 4.38 | 113.2 | 112.3 | 112.3 | 108.0 | 102.9 | 95.9 | 95.4 | 86.3 | 87.2 | 86.5 |
| New Mexico | 4.50 | 4.38 | 4.34 | 3.97 | 4.09 | 3.63 | 3.73 | 3.36 | 3.26 | 3.09 | 3.83 | 117.3 | 114.2 | 113.2 | 103.5 | 106.6 | 94.6 | 97.3 | 87.6 | 85.0 | 80.6 |
| Average | 4.73 | 4.65 | 4.63 | 4.35 | 4.30 | 3.91 | 3.95 | 3.57 | 3.54 | 3.44 | 4.11 | 115.3 | 113.2 | 112.7 | 105.7 | 104.8 | 95.3 | 96.3 | 86.9 | 86.1 | 83.5 |
| Average, 1936–39 | 3.00 | 3.00 | 2.93 | 2.84 | 2.75 | 2.61 | 2.53 | 2.41 | 2.30 | 2.22 | 2.66 | 113.0 | 112.7 | 110.3 | 106.8 | 103.4 | 98.2 | 95.1 | 90.6 | 86.5 | 83.3 |

relation that may be expected to hold under a wide range of growth conditions.

Mean data for yield of seed cotton on the middle rows in 1937, 1938, and 1939 also are shown in table 3. The trend in mean values for individual stations on the basis of either actual weights or percentages of station averages is closely similar to the trends exhibited in the 1936 data and for this reason requires little detailed comment.

A summary of analyses of variance by individual locations and years for yield on middle row in pounds is shown in table 4. The mean squares for total variance and for columns and rows vary widely with locations and seasons, owing to differential plant response to soil heterogeneity and to prevailing weather conditions. Mean-square variances for skips and error differ likewise with locations and seasons, but the variance due to skips was significantly greater than error in each of the 27 tests. This consistency establishes the fact that differences in skip length are definitely related to yield of the row in which the skip occurs.

TABLE 4.—*Analyses of variance for middle-row yields of seed cotton in table 3*

| Year and location | Mean squares [1] | | | | |
|---|---|---|---|---|---|
| | Total | Columns | Rows | Skips | Error |
| *1936* | | | | | |
| Alabama | 0.0432 | 0.0695 | 0.0570 | 0.1305 | 0.0272 |
| California | 1.9415 | 11.8040 | 4.3898 | 2.6891 | .3093 |
| Louisiana | .2464 | 1.3749 | .0610 | .5054 | .0962 |
| Mississippi | .2457 | .2611 | .9211 | .4967 | .1279 |
| New Mexico | .4904 | .3438 | 1.4734 | 2.3783 | .1498 |
| North Carolina | .1238 | .2396 | .3231 | .3403 | .0574 |
| Oklahoma | .0064 | .0037 | .0141 | .0241 | .0036 |
| Tennessee | .3561 | 2.1845 | .5189 | .6454 | .0710 |
| Texas | .0520 | .0718 | .1371 | .1156 | .0309 |
| *1937* | | | | | |
| Arizona (Mesa) | .7239 | 1.2953 | 1.6971 | 2.2600 | .3388 |
| Arizona (Sacaton) | .9297 | 1.3207 | 2.5111 | 2.0702 | .5406 |
| California | .8841 | 1.0727 | .5691 | 4.7456 | .4173 |
| Louisiana | .3720 | .7819 | .4259 | .8725 | .2515 |
| Mississippi | .7693 | 2.2131 | 2.4962 | 1.2476 | .3132 |
| North Carolina | .2726 | 1.2142 | .2124 | .9361 | .0796 |
| Oklahoma | .0336 | .0494 | .0453 | .0970 | .0222 |
| Tennessee | .1387 | .2375 | .3902 | .3133 | .0731 |
| Texas | .0482 | .0488 | .0648 | .2233 | .0231 |
| *1938* | | | | | |
| Arizona (Mesa) | .4225 | .4927 | .4454 | 2.0829 | .2034 |
| Arizona (Sacaton) | .4894 | .1247 | ---------- | 1.2558 | .4022 |
| California | .6101 | 1.1604 | .6218 | 2.1816 | .3434 |
| Mississippi | .1958 | .2362 | .2298 | .6265 | .1327 |
| North Carolina | .1404 | .1057 | .2057 | .5540 | .0848 |
| Tennessee | .1058 | .1037 | .1754 | .2050 | .0849 |
| Texas | .0511 | .0140 | .0686 | .3386 | .0177 |
| *1939* | | | | | |
| Arizona (Mesa) | .4038 | .6032 | .4759 | 2.3923 | .1213 |
| New Mexico | .3956 | .6244 | .1800 | 2.4911 | .1321 |

[1] Degrees of freedom: 99 for total; 9 for columns, rows, and skips; and 72 for error.

Significance was not established in any test for total-plot yield, but significance in yield on middle row was established in every test; consequently it is clear that some lateral compensation occurred in sections of the outside rows adjacent to the middle-row skips. In 1936 the average yield of outside rows was analyzed to test the gain of outside rows due to the presence of skips in the middle row. A gain in yield for outside rows adjacent to long skips over those adjacent to short skips or the perfect-stand check was evident at all

nine locations. At three locations variance for skip length exceeded error at odds of 19:1, but at six locations no significance was indicated. Since a trend was evident in all cases but was usually nonsignificant, the conclusion that gain in yield for rows adjacent to skips is generally not greatly different from error seems justified. Since total-plot yield and yield of middle rows indicated the relation adequately, separate calculations on the outside rows were not made in the remainder of the study.

### BOLL COUNTS AND YIELD ON 3-FOOT SEGMENT OF ROW

Boll counts were made on the first, second, and third 3-foot segments by rows on each plot as shown in the plan on page 2. These boll counts may be expected to measure the yield on plants adjacent to skips relative to those on plants occurring far enough away to be unaffected, and in this way the extent to which compensation occurs along the two parts of the middle row may be estimated. Boll counts on the third 3-foot segments (3–L and 3–R) could not be obtained on some of the 9- and 10-foot-skip plots because of the size of plot, and for this reason complete analyses of variance were limited to the first and second 3-foot segments.

Rather complete studies were made on all segment relations in the 1936 data. Averages of 3–L and 3–R, when these data were available, were compared with averages of 2–L and 2–R within each experiment, but no consistent differences were apparent; this indicates that compensation along the row does not generally extend beyond plants in the first 3-foot segment adjacent to the skip.

Lateral comparisons between 2–L, 3–L, 2–R, and 3–R segments revealed no consistent differences between row *b* and rows *a* and *c*. Likewise comparisons between 1–L and 2–L and 1–R and 2–R within rows *a* and *c* failed to show consistent trends. Consequently it is clear that compensation within a multiple-row plot occurs largely, if not entirely, on plants within 3 feet of the skip ends in the row having the skip and on plants in the adjacent segments of rows contiguous to the skip.

After the pattern of compensation within plots was established, analyses of data were continued only on those segments affected by skips and in this report only the minimum number of variables capable of adequately presenting the complete relations are included.

Boll counts were obtained at five locations in 1936, four locations in 1937, five locations in 1938, and one location in 1939. Summaries by locations for segments in the middle row for each skip length are given in table 5.

No significant differences occur between first and second 3-foot segments for the no-skip checks, but distinct differences are evident between the first and second segments for all skip lengths of 2 feet and greater. There is some tendency for the first segment on the longer skips to have slightly higher boll counts than on the shorter skips, but this trend is less evident at individual locations than in seasonal averages. The absence of any pronounced and consistent increase in boll counts on the first segment for increasing skip lengths suggests that a linear correction may be expected to apply reasonably well in making adjustments for missing segments in experimental work.

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TABLE 5.—*Boll counts on middle rows at various locations, 1936–39*

| Year and location | Boll counts for specified skip lengths and 3-foot segments | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | None | | 2 feet | | 3 feet | | 4 feet | | 5 feet | | 6 feet | | 7 feet | | 8 feet | | 9 feet | | 10 feet | | Average | |
| | 1st segment | 2d segment | 1st segment | 2d segment | 1st segment | 2d segment | 1st segment | 2d segment | 1st segment | 2d segment | 1st segment | 2d segment | 1st segment | 2d segment | 1st segment | 2d segment | 1st segment | 2d segment | 1st segment | 2d segment | 1st segment | 2d segment |
| *1936* | | | | | | | | | | | | | | | | | | | | | | |
| New Mexico | 67.9 | 73.6 | 77.7 | 70.8 | 82.2 | 67.8 | 83.7 | 65.6 | 78.5 | 68.6 | 75.7 | 71.2 | 74.4 | 67.1 | 85.0 | 72.2 | 75.4 | 69.1 | 79.5 | 64.7 | 78.0 | 69.1 |
| North Carolina | 42.3 | 46.4 | 52.6 | 43.2 | 54.3 | 46.3 | 57.6 | 43.5 | 54.7 | 38.8 | 57.8 | 41.1 | 62.3 | 39.2 | 57.6 | 42.6 | 57.6 | 43.4 | 59.6 | 44.1 | 55.6 | 42.9 |
| Oklahoma | | | 24.4 | 17.8 | 23.0 | 17.0 | 20.8 | 17.2 | 24.2 | 19.9 | 23.7 | 21.9 | 23.7 | 18.9 | 24.9 | 17.7 | 22.8 | 18.2 | 26.4 | 20.0 | 23.8 | 18.7 |
| Tennessee | 58.6 | 57.8 | 74.3 | 58.4 | 71.5 | 51.6 | 77.9 | 62.0 | 76.1 | 56.1 | 73.6 | 57.1 | 79.5 | 53.2 | 81.0 | 46.3 | 80.3 | 56.7 | 80.4 | 53.9 | 75.3 | 55.3 |
| Texas | 37.1 | 41.0 | 48.8 | 34.4 | 46.2 | 41.9 | 53.4 | 43.2 | 55.0 | 40.4 | 48.7 | 41.0 | 47.1 | 40.0 | 49.5 | 37.4 | 50.2 | 38.9 | 47.7 | 41.7 | 48.4 | 40.0 |
| Average | 51.5 | 54.7 | 55.6 | 44.9 | 55.4 | 44.9 | 58.7 | 46.3 | 57.7 | 44.8 | 55.9 | 46.5 | 57.4 | 43.7 | 59.6 | 43.2 | 57.3 | 45.3 | 58.7 | 44.9 | 56.2 | 45.2 |
| *1937* | | | | | | | | | | | | | | | | | | | | | | |
| Mississippi | 87.7 | 87.5 | 110.1 | 86.5 | 115.9 | 89.2 | 113.5 | 85.7 | 141.6 | 91.3 | 128.5 | 87.5 | 131.5 | 83.1 | 120.6 | 93.7 | 131.5 | 87.3 | 127.9 | 85.0 | 120.9 | 87.7 |
| North Carolina | 46.8 | 49.1 | 55.6 | 42.9 | 57.0 | 46.2 | 62.3 | 49.4 | 60.8 | 45.5 | 72.2 | 49.7 | 66.0 | 44.8 | 68.7 | 51.7 | 67.1 | 46.2 | 62.1 | 46.1 | 61.9 | 47.2 |
| Tennessee | 47.2 | 41.6 | 49.5 | 34.5 | 54.2 | 35.0 | 62.2 | 42.7 | 56.3 | 39.8 | 55.9 | 37.2 | 66.1 | 42.1 | 70.0 | 46.2 | 59.2 | 44.7 | 73.2 | 38.2 | 59.4 | 40.2 |
| Texas | 46.1 | 53.3 | 60.3 | 41.3 | 60.5 | 50.6 | 72.0 | 40.3 | 69.0 | 47.4 | 65.9 | 45.1 | 64.8 | 47.0 | 60.5 | 47.4 | 66.5 | 41.7 | 73.8 | 41.4 | 63.9 | 45.5 |
| Average | 56.9 | 57.9 | 68.9 | 51.3 | 71.9 | 55.2 | 77.5 | 54.5 | 81.9 | 56.0 | 80.6 | 54.9 | 82.1 | 54.2 | 79.9 | 59.7 | 81.1 | 55.0 | 84.2 | 52.7 | 76.5 | 55.1 |
| *1938* | | | | | | | | | | | | | | | | | | | | | | |
| Mississippi | 65.5 | 71.5 | 90.2 | 70.1 | 88.0 | 70.6 | 102.3 | 66.4 | 103.2 | 71.7 | 109.3 | 69.3 | 107.2 | 71.2 | 117.7 | 74.5 | 110.1 | 69.7 | 105.8 | 70.4 | 99.9 | 70.5 |
| North Carolina | 46.7 | 43.8 | 53.4 | 48.8 | 59.7 | 44.3 | 56.6 | 47.1 | 63.5 | 43.3 | 58.1 | 43.5 | 58.7 | 37.8 | 59.2 | 37.2 | 66.4 | 44.3 | 57.6 | 43.0 | 58.0 | 43.3 |
| Oklahoma | | | 71.8 | 58.0 | 75.2 | 61.7 | 72.7 | 64.5 | 77.4 | 64.4 | 88.6 | 57.4 | 85.1 | 60.4 | 80.5 | 63.1 | 78.8 | 59.0 | 85.0 | 57.4 | 79.4 | 60.6 |
| Tennessee | 37.5 | 34.2 | 41.9 | 32.8 | 43.2 | 28.8 | 43.0 | 30.3 | 44.2 | 30.9 | 40.6 | 31.2 | 43.3 | 28.3 | 45.3 | 31.6 | 47.7 | 28.7 | 42.9 | 35.0 | 43.0 | 31.2 |
| Texas | 34.0 | 33.1 | 42.1 | 33.4 | 46.2 | 31.9 | 43.4 | 33.9 | 48.6 | 31.2 | 48.6 | 34.1 | 44.0 | 32.4 | 46.2 | 35.9 | 45.7 | 34.4 | 43.1 | 34.6 | 44.2 | 33.5 |
| Average | 45.9 | 45.6 | 59.9 | 48.6 | 62.5 | 47.5 | 63.6 | 48.4 | 67.4 | 48.3 | 69.0 | 47.1 | 67.7 | 46.0 | 69.8 | 48.5 | 69.7 | 47.2 | 66.9 | 48.1 | 64.9 | 47.8 |
| *1939* | | | | | | | | | | | | | | | | | | | | | | |
| New Mexico | 77.8 | 76.4 | 78.2 | 73.8 | 81.4 | 74.7 | 81.7 | 71.5 | 87.4 | 69.1 | 87.8 | 71.7 | 87.7 | 75.5 | 86.9 | 73.0 | 82.9 | 72.9 | 88.5 | 73.2 | 84.0 | 73.2 |
| Average, 1936–39 | 53.5 | 54.6 | 62.1 | 49.8 | 63.9 | 50.5 | 66.9 | 50.9 | 69.4 | 50.5 | 69.0 | 50.6 | 69.4 | 49.4 | 70.2 | 51.4 | 69.5 | 50.3 | 70.2 | 49.9 | 66.6 | 50.7 |

At Baton Rouge, La., weights of seed cotton instead of boll counts were determined for 3-foot segments, and summaries of these yields are shown in table 6. In 1936 an increase in yield for the first 3-foot segment is evident for the 2-foot skip length, and there is some evidence of a progressive increase with increasing skip lengths. In 1937 there is somewhat stronger evidence of an association between yield of the first 3-foot segment and increasing skip length, indicating that in this test somewhat greater compensation occurred in those plots containing longer skips than in those with shorter ones.

TABLE 6.—*Yield of seed cotton in pounds on 3-foot segments of middle row in Louisiana, 1936 and 1937*

| Skip length (feet) | 1936 | | 1937 | | Average | |
|---|---|---|---|---|---|---|
| | 1st segment | 2d segment | 1st segment | 2d segment | 1st segment | 2d segment |
| 0 | 0.315 | 0.302 | 0.449 | 0.472 | 0.382 | 0.387 |
| 2 | .371 | .300 | .636 | .545 | .503 | .422 |
| 3 | .413 | .274 | .672 | .498 | .542 | .386 |
| 4 | .490 | .324 | .749 | .545 | .619 | .434 |
| 5 | .466 | .253 | .813 | .546 | .640 | .399 |
| 6 | .505 | .338 | .787 | .566 | .646 | .452 |
| 7 | .467 | .297 | .868 | .486 | .667 | .391 |
| 8 | .438 | .274 | .823 | .504 | .630 | .389 |
| 9 | .524 | .354 | .956 | .480 | .740 | .417 |
| 10 | .450 | .297 | .923 | .510 | .686 | .403 |
| Average | .444 | .301 | .768 | .515 | .606 | .408 |

A summary of the analyses of variance for boll counts on first and second 3-foot segments in the middle row is shown in table 7. A comparison of mean squares among locations indicates wide differences in heterogeneity of data among the various places. This is reflected not only in total variance but also in all components of the whole-plot and split-plot portions of the analyses. However, comparisons within any one station are valid, even though combined analyses might be of questionable value. The whole-plot portion of the analyses measures the total effect of boll counts or seed-cotton weights for the sum of the first and second 3-foot segments. It is not surprising, therefore, that at many locations skip length fails to exceed error (a) significantly, since the mean values indicate that the major differences are between the first and second 3-foot segments.

In the split-plot portion of the analyses variance due to positions measures the average difference between the first and second 3-foot segments and that due to positions $\times$ skips measures the differential in boll counts or weight of seed cotton among the various skip lengths. At every location the variance due to positions significantly exceeds not only error (b) but positions $\times$ skips as well, which indicates that the differences between the first and second segments are unquestionably significant and that these differences are largely independent of the skip length. These findings indicate that a linear correction is generally satisfactory in making adjustments for skips, or missing segments, in field experimental work.

TABLE 7.—*Analyses of variance for boll counts in table 5 and for yields of seed cotton in table 6*

BOLL COUNTS OF TABLE 5

| Year and location | Mean squares [1] | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | Whole plot | | | | Split plot | | | | | |
| | Rows | Columns | Skips | Error (a) | Positions | Positions × skips | Positions × rows | Positions × columns | Error (b) | |
| *1936* | | | | | | | | | | |
| New Mexico | 10.5302 | 1.8070 | 1.0829 | 1.2068 | 39.8725 | 2.2874 | 0.8087 | 1.1610 | 1.1904 | 1.8672 |
| North Carolina | 3.2934 | 2.8312 | 1.0269 | .7799 | 81.6642 | 2.5939 | .2746 | .5949 | .6165 | 1.3595 |
| Oklahoma | .4154 | .3515 | .2799 | 11.4005 | .1452 | 1.3928 | .0945 | .3409 | | |
| Tennessee (Knoxville) | 305.3339 | 1,692.4450 | 234.0561 | 147.6131 | 20,020.0050 | 403.0606 | 229.9383 | 368.7606 | 127.7869 | 346.4882 |
| Texas (Greenville) | 151.9467 | 88.3689 | 142.5356 | 69.3869 | 3,511.2200 | 153.2311 | 88.4200 | 118.1533 | 74.8686 | 103.4247 |
| *1937* | | | | | | | | | | |
| Mississippi | 3,694.1467 | 3,456.6356 | 1,220.2356 | 647.7522 | 55,112.0000 | 1,162.2222 | 376.3778 | 260.7778 | 360.0333 | 110.1529 |
| North Carolina | 2.3376 | 11.4036 | 3.6045 | .9123 | 108.0450 | 2.5573 | .4035 | .7762 | .8511 | 2.1345 |
| Tennessee (Knoxville) | 229.3978 | 437.7422 | 587.7756 | 217.3325 | 18,393.6200 | 292.3089 | 261.7311 | 121.2311 | 132.8603 | 306.4280 |
| Texas (Greenville) | 242.7606 | 149.3161 | 148.1717 | 107.5314 | 16,909.6050 | 659.0383 | 105.8494 | 59.9828 | 95.5008 | 220.1708 |
| *1938* | | | | | | | | | | |
| Mississippi | 186.9561 | 520.8006 | 1,171.3228 | 206.5519 | 41,443.2050 | 1,323.7494 | 368.2050 | 159.7383 | 187.1675 | 519.4369 |
| North Carolina | 105.8556 | 219.7556 | 164.8556 | 81.4486 | 10,775.1200 | 247.5200 | 88.0644 | 165.4089 | 90.6797 | 161.2638 |
| Oklahoma | 1.8546 | 1.3402 | 1.9495 | 159.0480 | 2.9254 | 2.5816 | 1.2808 | 2.6119 | | |
| Tennessee (Knoxville) | 98.3911 | 316.4578 | 28.4800 | 136.6953 | 6,938.0200 | 108.9422 | 12.6978 | 118.4978 | 79.8853 | 144.1357 |
| Texas (Greenville) | 65.0867 | 67.1756 | 96.5200 | 49.0394 | 5,724.5000 | 99.9667 | 37.1333 | 40.7556 | 59.1361 | 86.2958 |
| *1939* | | | | | | | | | | |
| New Mexico | 2.0820 | 4.6146 | .6918 | .8035 | 58.8613 | 1.4626 | .8828 | .7853 | .6868 | 1.3107 |

YIELD OF SEED COTTON, IN POUNDS, OF TABLE 6

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *1936* | | | | | | | | | | |
| Louisiana | 0.003697 | 0.078631 | 0.033058 | 0.009338 | 1.018165 | 0.016778 | 0.004796 | 0.007913 | 0.009564 | 0.018507 |
| *1937* | | | | | | | | | | |
| Louisiana | .025159 | .050946 | .120713 | .015830 | 3.181503 | .115926 | .020806 | .014514 | .009739 | .040980 |

[1] Degrees of freedom: 199 for total; 9 for rows, columns, skips, positions × skips, positions × rows, positions × columns; 1 for positions; and 72 for errors (a) and (b).

The following equation is suggested for single-row plots if skip distances are measured from the main stem of plants adjacent to the skip:

$$\text{Adjusted yield} = \text{actual yield} \times \frac{\text{total row length in feet}}{\text{total row length} - (\text{skip distance} - 3\text{ ft.})}.$$

If distances are measured from the tips of branches of the plants adjacent to the skip, the equation suggested for single-row plots is as follows:

$$\text{Adjusted yield} = \text{actual yield} \times \frac{\text{total row length in feet}}{\text{total row length} - \text{skip distance}}.$$

## DISCUSSION

In applying the method of skip correction indicated by these studies to extensive cotton variety tests, it has been found that the adjusted yields usually were reasonable in amount. In a relatively small number of cases the correction obtained by applying the formula appeared to be either too great or too small, and in such cases it was difficult to determine whether local soil variability or the formula should be suspected as responsible for the apparent discrepancy. The approximate equality in number of cases of suspected overcorrection and undercorrection indicates that the formula is without detectable bias and suggests that apparent discrepancies may be due largely to soil heterogeneity of the type that occasionally causes wide differences in yield among individual rows in multiple-row plots.

The need for an upward adjustment in yield of single-row plots containing skips and the evidence that compensation occurs laterally in adjacent rows raise the question whether a downward adjustment should be made in the yield of rows adjacent to those containing skips. Studies of average yields of outside rows for the nine locations in 1936 indicated a slightly higher yield for outside rows adjacent to longer skips than for those adjacent to shorter skips. In the analyses of variance for single locations the effect of skip length on yield of outside rows exceeded the 5-percent level of probability at three locations and was nonsignificant at the other six. Since the advantage gained by outside rows from different skip lengths did not reach high significance (odds 99:1) at any location and reached the level of interest, or low significance (odds 19:1), at only one-third of the places, the need for adjustment is by no means clear. These tests were based on an average of the two outside rows and thus reflect a cumulative advantage. It follows that, if tests were made on single outside rows, the expectation of finding significant advantages would be less. From all the evidence available it may be concluded that in the majority of cases gains in single rows adjacent to skips on one side are likely to be within experimental error. Under such circumstances it seems doubtful if a downward adjustment should be made in rows adjacent to those containing skips.

Average yields of seed cotton from whole plots, for each year and for the 3-year period 1936 to 1938 at the Delta Branch Station, Stoneville, Miss., were summarized by Neely.[7] Conclusions and recommen-

[7] NEELY, J. W. IRREGULAR STANDS MAY NOT DECREASE YIELDS OF COTTON. Miss. Farm Res. 4 (4): 1, 8. 1941.

dations coincide with those from the whole study. Since the experiments at this station were conducted on fertile Delta soil and others in the study were carried out at locations representing various levels of fertility and a wide range of climatic conditions, the agreement in conclusions from the various experiments indicates that the compensation for missing segments is similar under a wide range of soil and climatic conditions.

Yields of middle rows and whole plots for the three experiments conducted at Baton Rouge, La., have been summarized by Cotton.[8] The conclusions from these studies on the necessity for adjusting yields coincide substantially with those from the whole study. There is some evidence that, under conditions of heavy and well-distributed rainfall, corrections in single-row plots may not be necessary for skips less than 5 or 6 feet in length.

## SUMMARY

Twenty-seven skip-correction tests, based on perfect-stand checks and skip distances of 2, 3, 4, 5, 6, 7, 8, 9, and 10 feet in the middle row of 3-row 25-foot plots, were conducted during the 4-year period from 1936 to 1939. At each location the experiments were arranged as 10 by 10 Latin squares. Yield data were obtained by individual rows, and boll counts or weights of seed cotton were taken on 3-foot segments in the middle row and on certain segments of outside rows.

Yield studies were made both on the whole plots and on the middle rows in order to evaluate the effect of skips, or missing segments of row, on yield. The whole-plot analyses indicated a slight but nonsignificant reduction in yield with increasing skip increments.

Analyses of variance on yield of middle rows showed a significant reduction in yield due to skips in each of the 27 experiments, and this reduction was largely linear beyond a skip distance of 3 feet.

Analyses of variance were made on boll counts for the first and second 3-foot segments adjacent to the skip in the middle rows of each plot. The means and analyses of variance indicated that there was compensation by plants in the middle-row segments adjacent to the skip but that this compensation was largely independent of skip length, which suggests that the end plants may compensate for only a limited portion of the reduction in yield due to the skip.

From all the information available from these 27 tests 2 conclusions appear reasonable: (1) Skips occurring on interior rows of multiple-row plots are largely compensated for by increased production on end plants in the row containing the skip and by lateral compensation on the adjacent rows; (2) in single-row plots there is a definite reduction in yield due to skips, and this reduction appears to be substantially linear for distances greater than 3 feet. Consequently, for single-row plots a linear correction for skip distance minus 3 feet may be expected to give a satisfactory adjustment in computing yields if skip length is measured from stalk to stalk of plants adjacent to skips. If measurement is from nearest branches of plants adjacent to skips. a linear correction for actual skip distance is suggested.

[8] COTTON, J. R. SOME PRELIMINARY NOTES ON A SKIP CORRECTION STUDY IN LOUISIANA. Paper presented at meeting of the Association of Southern Agricultural Workers, New Orleans, La., 1939. [Unpublished.]

# PHOTOPERIODIC BEHAVIOR OF MARYLAND MAMMOTH TOBACCO UNDER LOCALIZATION TREATMENTS AND IN GRAFTS WITH CONNECTICUT BROADLEAF[1]

By H. A. ALLARD

*Senior physiologist, Division of Tobacco, Medicinal, and Special Crops, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture*

## INTRODUCTION

The Maryland Mammoth variety of tobacco (*Nicotiana tabacum* L.) is distinctive in having short-day requirements; that is, it normally flowers in response to naturally shortening days in northern latitudes. For this reason it is a very late flowering variety when grown commercially in the field in Maryland. This behavior is in marked contrast to that of all other commercial varieties of tobacco, which are day-neutral in their flowering behavior.

Various workers have concluded from their experimental results that the stimulus which initiates flowering originates in the leaves of the plants and not in the tissues of the growing point. This influence, the actual nature of which is unknown at present, is considered to affect other portions of suitably treated plants and to cause flowering in these even when they never have been subjected to a favorable photoperiod. The view generally held at present is that a flowering hormone or chemical substance capable of diffusing from cell to cell ultimately reaches remote tissues of a plant or graft, causing it to flower without the stimulus of a favorable photoperiod.

## LOCALIZATION TREATMENTS ON BRANCHES OF MARYLAND MAMMOTH TOBACCO

Localization treatments were designed to determine whether short-day conditions favorable to flowering localized upon the leaves of branches of Maryland Mammoth plants would induce flowering in other portions of the same plant subjected to lengths of day in excess of that critical for flowering. Seed of the Maryland Mammoth tobacco was sown January 21, 1943, and germinated January 27, and the plants were potted in thumb pots February 22. These were transferred to 4-inch pots April 14, to large pails June 7, and to DeWitt cans July 2. For the localization tests, three lightproof, ventilated cases of wood with the following inside dimensions were used: Height 38½; width 22½; and length 28½ inches. The east, west, and north sides were fitted with removable doors. During the tests a

[1] Received for publication December 14, 1944.

daylight period of 8 hours and 15 minutes was allowed that portion of the plant within the case, the doors being removed at 8 a. m. and replaced at 4:15 p. m. The three tests began July 23.

In the first test a vigorous young Maryland Mammoth plant 29 inches tall was so placed on the south side of the case that eight large leaves of one side of the plant were entirely within the case. The spaces between the leaves were then closed by heavy cardboard and black cloth so that, when the east, west, and north doors were closed from 4:15 p. m. to 8 a. m., these leaves were completely darkened, being exposed each day, as previously stated, to about 8 hours of light, a photoperiod conducive to flowering in the Maryland Mammoth variety.

The stem and leaves remaining outside experienced the full day. The dimensions, in inches, of the 8 darkened leaves at maturity were as follows: 16 by 11; 14 by 7½; 15½ by 8¼; 17 by 8; 17 by 8¼; 17¼ by 9; 15½ by 7; and 17 by 7. By October 12 all these leaves had died. On the stem outside the case, subjected to the full seasonal length of day, flower buds did not appear until September 10. The first flowers opened September 16, 55 days after the test began, the plant at that time having a height of 90 inches. Fifty-eight leaves were counted to the first flowering branch of the inflorescence. This treated plant flowered no earlier than some of the control, untreated Maryland Mammoth plants. The control plants budded and flowered as follows. Plant 1: Buds, August 25; flowers, September 10 at 90 inches. Plant 2: Buds, August 25; flowers, September 3 at 86 inches. Plant 3: Buds, August 30; flowers, September 10 at 90 inches. Plant 4: Buds, August 25; flowers, September 1 at 85 inches. These plants produced approximately 65 to 70 leaves, counting all leaf scars and leaves to the first flowering branch. The 3 largest leaves averaged about 20 by 7½ inches.

In the second test, which also began July 23, a Maryland Mammoth plant which had produced two vigorous lateral branches as the result of cutting back the main stem about 7 inches from the ground was used. The plant and container were kept outside on the south side of the case. One branch 8 inches long was placed within, and the stem was defoliated and wrapped with black cloth where it passed through the opening in the case so that no light could enter there. When the test began, the outside branch was 16 inches long as measured from the ground. The inside branch was afforded about 8 hours of light as in the first test, since the same schedule of opening and closing was observed. The outside branch was kept defoliated from the beginning of the test, only the youngest, topmost leaves below the growing point being left as the defoliation was continued.

Defoliation appears to have produced no effect, unless it was an actual slight delay in flowering. Buds appeared on the inside branch August 30, 38 days after the test began, and the first open flowers September 29, 68 days from the beginning of the test, when the branch had reached a height of 37 inches. At this time the three largest basal leaves measured 23 by 8, 21 by 7½, and 23 by 9½ inches, respectively. Thirty-four leaves had developed to the first flowering branch.

The outside defoliated branch experiencing full day showed buds September 29, at the end of 68 days, just 30 days later than the inside branch. The first open blossoms appeared October 9, 78 days after the test began, at a height of 45 inches. Seventy-eight leaves had been removed from the outside stem. This stem, remaining slender and scarcely longer than the inside flowering stem, bore only a small inflorescence. The stem was considerably smaller than those of the control plants, which were afforded the full day and had not been defoliated. However, both flowering dates were later than those for the four controls discussed in connection with test 1.

In the third test, also begun on July 23, a Maryland Mammoth plant was cut back and arranged as in test 2 so that one branch remained within the case. This branch was afforded about 8 hours of daylight, while the one without experienced the full day. Neither branch was defoliated.

On November 12, 112 days after the test began, the inside branch, subjected to the short photoperiod, had not budded, was only 26 inches long, and had produced only 24 leaves, counting all to the terminal bud. The outside branch, experiencing the full day, showed buds September 10 and the first open flowers September 22, 61 days after the test began, at a height of 74 inches. However, both flowering dates are later than those for the 4 controls discussed in connection with test 1. On November 12 the outside branch had attained a height of 80 inches and had produced 54 leaves. The 3 largest outside leaves measured 20½ by 6½, 21 by 7, and 20 by 6½ inches, respectively. The leaves of the inside branch were noticeably smaller and narrower, the largest leaf being 18 by 5½ inches.

Since flowering in the Maryland Mammoth variety is favored by short days, the failure of the inside branch to flower under the conditions of this localization test appears somewhat anomalous. It is possible that some lack of physiological balance, brought about by the two competing shoots under these conditions, delayed flowering in the shoot experiencing the short photoperiod. It is also possible that these tests were begun too late in the season and therefore too near the critical length of day to get striking differences in time of flowering.

The experiments with Maryland Mammoth, in the same lightproof cases and with the same methods of treating and darkening the plants, were repeated in 1944, the tests beginning May 29. In one test the outside receptor branch was defoliated and wrapped with lightproof black cloth from June 5 until July 18, 43 days. The inside branch receiving about 8 hours of light daily flowered July 14, 46 days after the tests began. The defoliated and wrapped outside branch had shown no buds September 1, 95 days after the tests began.

In a second test, also begun May 29, the outside receptor branch was defoliated even to the removal of all the auricles from July 18 to September 1, 45 days. The inside darkened branch showed buds about August 29. At this time the outside defoliated receptor branch had not budded. These tests possibly indicate that the 1943 experiments were begun too late in the season to secure pronounced differences in flowering. Even in these later tests, there was no

indication that the receptor branch experiencing a length of day too long to induce flowering received any impulse conducive to earlier flowering even when kept defoliated or when defoliated and also wrapped with lightproof black cloth.

## MARYLAND MAMMOTH IN GRAFTS WITH CONNECTICUT BROADLEAF TOBACCO

The publication of the early work of Garner and Allard (*7*),[2] showing the results of localizing different length-of-day treatments upon the branches of a plant, stimulated a vast amount of similar experimental work on various plants. It would appear that the photoperiodic stimulus tends to remain localized in its effects and confined to the treated branch as long as the rest of the plant experiences a length of day unfavorable to flowering and is not given additional treatment. If, however, the leaves of the branch which does not flower are removed or rendered more or less functionless by darkness, the flowering stimulus operates as well upon this branch, which has been termed the "receptor," and the initiation of flowering results. The experiments presented in this section were designed to determine whether this behavior also holds true in the case of the short-day Maryland Mammoth tobacco when grafted with the day-neutral Connecticut Broadleaf variety. Both plants were used as stock and scion. One lot was grown in beds in a rich soil, where the plants were afforded a much greater amount of space and soil for root development than pails or DeWitt cans provide. In other tests 14-quart pails or DeWitt cans of 32-quart capacity were used. Presumably owing to their limited soil capacity, these containers produced smaller and somewhat earlier flowering plants, as can be seen from a comparison of the data of tables 1 and 2.

For the plants grown in the west bed, seed of the Maryland Mammoth variety (1935 harvest) was sown September 7, 1942. This germinated September 12. The plants were transplanted to thumb pots October 18 and to pails November 17 and were cut back to a height of 4 to 5 inches from the soil in the spring. The grafts were made on the dates indicated in tables 1 and 2. Some of the plants were transferred to the beds June 4; the data on the behavior of these are shown in table 1. Some of the plants remained in pails or were transferred to DeWitt cans; the data for the behavior of these are shown in table 2. The Connecticut Broadleaf plants used for all the grafts were obtained from seed sown January 21, 1943. This germinated January 27. The plants were transferred to thumb pots February 22.

The data of table 1 are derived from plants grown in 2 beds, 16 plants in each bed. Plants 1 to 16, Maryland Mammoth variety, were used as stocks upon which 1 or 2 scions of Connecticut Broadleaf were grafted. Plants 17 to 26, Connecticut Broadleaf variety, were used as the stocks grafted with 1 or 2 scions of Maryland Mammoth. Plants 27 to 32, Maryland Mammoth variety, were not treated in any way and were used as controls. The Maryland Mammoth

[2] Italic numbers in parentheses refer to Literature Cited, p. 30.

branches of plants 2 to 8 were kept defoliated from June 18. The leaves were kept removed to the tip, leaving only the small, very immature bud leaves. The defoliated portion of the stalk of plant 3 was also kept covered with light-impervious black cloth.

Table 1 shows that not one of plants 2 to 8, the Maryland Mammoth branches of which were defoliated or defoliated and wrapped with black cloth, had shown buds until after November 20, 221 days after the grafts were made, although defoliation of these plants had been maintained for 155 days. Since the Connecticut Broadleaf scions flowered through a range of 77 to 116 days after the grafts were made, there was a period ranging from 105 to 144 days after the flowering of the scions during which any active flower-forming material originating in the plants could have operated as a flowering stimulus in the Maryland Mammoth branches.

Plants 9 to 16 represented grafts of Connecticut Broadleaf scions upon Maryland Mammoth stocks without any additional treatments given to either stock or scion. Since the Connecticut Broadleaf scions in this series flowered within a range of 77 to 108 days after the grafts were made and the Maryland Mammoth branches had not budded until after November 20, 221 days from the date of grafting, it is evident that there was an interim of 113 to 144 days when flower-forming material could have been available to these Maryland Mammoth branches. This would depend upon the assumption that it became available only at the time of blossoming of the Connecticut Broadleaf scions.

The behavior of these defoliated and nondefoliated groups of plants would indicate that the defoliation treatments of the Maryland Mammoth branches had failed to hasten the formation of buds or flowers under the conditions of these experiments.

Plants 17 to 26 represented grafts in which the Connecticut Broadleaf served as stocks and the Maryland Mammoth as scions. In this group, excluding plants 18, 19, and 21, the Maryland Mammoth scions and the branches of the Connecticut Broadleaf stock were allowed to develop with no further treatment after the grafts were made. The scions of two plants in this group, 18 and 19, budded or flowered in advance of the rest; plant 18 showed buds October 20, 190 days from the date of grafting, but subsequent flowering seemed to be delayed. Other plants in this group had not budded in October but had budded or were in flower in early December, more than 231 days after the date of grafting. Plant 19 flowered in 183 days.

Plants 27 to 32, variety Maryland Mammoth without grafts or treatment of any kind, served as controls. Only one, plant 28, had flowered by October 12, 182 days from the time of the grafting with Connecticut Broadleaf plants. The other plants did not bud until after November 20, at least 221 days after grafting.

Table 2 presents data for 38 plants grown either in pails or in the much larger DeWitt cans. Plants 1 to 21 were Maryland Mammoth upon which 1 or 2 scions of Connecticut Broadleaf had been grafted; the scions failed to unite on plants 1 to 5 and 10. Plant 6 failed to develop a branch from the Maryland Mammoth stock. Scions of Connecticut Broadleaf grew successfully on plants 11 to 18.

TABLE 1.—*Responses of late-flowering, short-day Maryland Mammoth and of early-flowering, day-neutral Connecticut Broadleaf tobaccos in grafts and of ungrafted Maryland Mammoth grown in beds*

[Grafts made April 13, 1943]

| Scion, stock, and plant No. | Scions used | Treatment of stock | Treatment of scion | Response of Connecticut Broadleaf: Appearance of buds: Date | Response of Connecticut Broadleaf: Appearance of buds: Scion or stock responding | Response of Connecticut Broadleaf: Appearance of flowers: Date | Response of Connecticut Broadleaf: Appearance of flowers: Period from grafting to flowering | Response of Connecticut Broadleaf: Appearance of flowers: Height | Response of Maryland Mammoth [1]: Date of appearance of buds | Response of Maryland Mammoth [1]: Appearance of flowers: Date | Response of Maryland Mammoth [1]: Appearance of flowers: Period from grafting to flowering | Response of Maryland Mammoth [1]: Appearance of flowers: Height | Response of Maryland Mammoth [1]: Appearance of flowers: Period from flowering of Connecticut Broadleaf to that of Maryland Mammoth |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Connecticut Broadleaf on Maryland Mammoth: | *Number* | | | | *Number* | | *Days* | *Inches* | | | *Days* | *Inches* | *Days* |
| 1 | 2 | None | 1 kept defoliated from June 6. | | 1 | June 4 | 52 | 30 | Late November. | Nov. 30 | 231 | [2] 70 | 179 |
| | | | | | 2 | July 7 | 85 | | | | | | 146 |
| 2 | 2 | 1 branch kept defoliated from June 18, leaving only small leaves at tip. | None | July 24 | 2 | July 30 | 108 | 64 | do | do | 231 | [2] 62 | 123 |
| | | | | | | Aug. 7 | 116 | 80 | | | | | 115 |
| 3 | 1 | Branch kept defoliated to tip from June 18. Defoliated portion covered with lightproof black cloth. | do | June 25 | 1 | July 6 | 84 | 50 | do | do | 231 | [2] 50 | 147 |
| 4 | 1 | Branch kept defoliated to tip from June 18. | do | do | 1 | July 7 | 85 | 59 | do | do | 231 | [2] 55 | 146 |
| 5 | 1 | Branch kept defoliated to tip from June 18; this remained slender. | do | June 24 | 1 | July 28 | 106 | 75 | do | do | 231 | [2] 66 | 125 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 1 | Branch kept defoliated from June 18. | do | July 24 | 1 | July 29 | 107 | 50 | do | do | 231 | [2] 45 | 124 |
| 7 | 2 | 1 branch kept defoliated from June 18. | do | June 29<br>July 13 | 2 | July 7<br>July 24 | 85<br>102 | 65<br>54 | do | do | 231 | [2] 72 | 146<br>129 |
| 8 | 1 | do | do | June 24 | 1 | June 29 | 77 | 65 | do | do | 231 | [2] 61 | 154 |
| 9 | 1 | Branch not treated | do | June 29 | 1 | July 8 | 86 | 70 | do | do | 231 | [1] 140 | 145 |
| 10 | 1 | do | do | July 7 | 1 | July 17 | 95 | 69 | do | do | 231 | [1] 130 | 136 |
| 11 | 2 | Branches accidentally broken off Sept. 4, when 80 inches tall, leaving 40 inches. | do | June 29<br>July 7 | 2 | July 7<br>July 12 | 85<br>90 | 70<br>50 | do | do | 231 | [1 2] 60 | 146<br>141 |
| 12 | 2 | Branches not treated. | do | June 29<br>July 7 | 2 | July 12<br>July 20 | 90<br>98 | 73<br>75 | do | do | 231 | [1] 144 | 141<br>133 |
| 13 | 1 | Branch accidentally broken off Oct. 8, when 169 inches tall, leaving 100 inches. | do | July 24 | 1 | July 30 | 108 | 88 | do | do | 231 | ([1 2]) | 123 |
| 14 | 1 | Branch accidentally broken off when 60 inches tall Aug. 17, leaving 30 inches. | do | July 7 | 1 | July 12 | 90 | 70 | do | do | 231 | [1 2] 44 | 141 |
| 15 | 1 | Branch accidentally broken off Aug. 17, when 70 inches tall, leaving 32 inches. | do | June 24 | 1 | June 29 | 77 | 47 | do | do | 231 | [1 2] 65 | 154 |
| 16 | 1 | Branch accidentally broken off Oct. 8 near tip. | do | June 29 | 1 | July 5 | 83 | 57 | do | do | 231 | [1 2] 168 | 148 |
| Maryland Mammoth on Connecticut Broadleaf: | | | | | | | | | | | | | |
| 17 | 2 | | Branch broken off Oct. 8, when 110 inches tall, leaving 82 inches. | July 12 | 2 | July 24<br>July 27 | 102<br>105 | 74<br>75 | do | do | 231 | ([1 2]) | [illegible] 129<br>[illegible] 126 |
| 18 | 1 | Branch cut back June 18. | Branch not treated. | July 12 | 1 | July 20 | 98 | 83 | Oct. 20 with delayed flowering. | | | 120 | |

See footnotes at end of table.

TABLE 1.—*Responses of late-flowering, short-day Maryland Mammoth and of early-flowering, day-neutral Connecticut Broadleaf tobaccos in grafts and of ungrafted Maryland Mammoth grown in beds*—Continued

[Grafts made April 13, 1943]

| Scion, stock, and plant No. | Scions used | Treatment of stock | Treatment of scion | Response of Connecticut Broadleaf | | | | | Response of Maryland Mammoth [1] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Appearance of buds | | Appearance of flowers | | | Date of appearance of buds | Appearance of flowers | | | |
| | | | | Date | Scion or stock responding [2] | Date | Period from grafting to flowering | Height | | Date | Period from grafting to flowering | Height | Period from flowering of Connecticut Broadleaf to that of Maryland Mammoth |
| Maryland Mammoth on Connecticut Broadleaf—Con.: | *Number* | | | | *Number* | | *Days* | *Inches* | | | *Days* | *Inches* | *Days* |
| 19 | 1 | Branch cut back June 18 and again July 2 to promote growth of the dwarfed Maryland Mammoth scion. | Branch not treated. | July 23 | 1 | Aug. 3 | 112 | 69 | Oct. 7 | Oct. 13 | 183 | 69 | 71 |
| 20 | 1 | do | do | July 12 | 1 | July 24 | 102 | 74 | Late November | | 231 | [1] 160 | 129 |
| 21 | 1 | Cut back branch July 2, as the Maryland Mammoth scion remained very small. | Remained very small with leaves not more than 2–2½ inches long. | July 24 | 1 | Aug. 11 | 120 | 82 | do | | 231 | [3] 36 | 111 |
| 22 | 1 | Branch not treated. | Branch not treated. | July 7 | 1 | July 17 | 95 | 73 | do | | 231 | [1] 126–156 | 136 |
| 23 | 1 | do | do | July 24 | 1 | July 29 | 107 | 88 | do | | 231 | [1] 74 | 124 |
| 24 | 1 | do | do | July 11 | 1 | July 17 | 95 | 80 | do | | 231 | [1] 170 | 136 |
| 25 | 1 | do | do | July 24 | 1 | Aug. 5 | 114 | 79 | do | | 231 | [1] 120 | 117 |
| 26 | 2 | Branches not treated. | Branches not treated. | June 29 | 2 | July 7 | 85 | 59 | do | | 231 | [1] 36–100 | 146 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ungrafted and untreated Maryland Mammoth (controls): | | | | | | | | | | | | | | |
| 27 | | | | | | | | | | Apical branching preparatory to flowering in late November. | | (4) | [1] 172 | |
| 28 | | | | | | | | | | | Oct. 12 | [4] 182 | [1] 168–180 | |
| 29 [4] | | | | | | | | | | | | [4] 231 | [1] 168–180 | |
| 30 | | | | | | | | | | | | [4] 231 | [1] 168–180 | |
| 31 | | | | | | | | | | | | [4] 231 | [1] 168–180 | |
| 32 | | | | | | | | | | | | [4] 231 | [1] 168–180 | |

[1] All controls and Maryland Mammoth branches were budded or in flower when the experiment was discontinued in early December, unless otherwise indicated.

[2] The plants for the most part and new growth of branches previously broken had not budded Oct. 12. The defoliated Maryland Mammoth branches showed no signs of buds when the experiment was discontinued in early December.

[3] No buds evident when the experiments were discontinued in early December.

[4] Time of flowering computed from April 13, when Maryland Mammoth plants of the same age (1 to 26, inclusive) were grafted with Connecticut Broadleaf, to November 30 unless some other date given.

[4] 2 branches developed.

TABLE 2.—*Responses of late-flowering, short-day Maryland Mammoth and of early-flowering, day-neutral Connecticut Broadleaf tobaccos in grafts and of ungrafted Maryland Mammoth grown in pails or DeWitt cans, 1943*

| Plant No. | Date of grafting | Scions used | Condition or treatment of scion or stock | Response of Connecticut Broadleaf scion | | | | Response of Maryland Mammoth | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Appearance of flowers | | | | Appearance of flowers | | | | |
| | | | | Date of appearance of buds | Date | Period from grafting to flowering | Length of scion | Date of appearance of buds | Date | Period from grafting to flowering | Height | Period from flowering of Connecticut Broadleaf to that of Maryland Mammoth |
| | | *Number* | | | | *Days* | *Inches* | | | *Days* | *Inches* | *Days* |
| 1 | Apr. 23 | 1 | Scion did not unite; 2 branches of stock developed. | | | | | Sept. 10 | Sept. 28 | 158 | 61 | |
| | | | | | | | | | | 158 | 64 | |
| 2 | do | 1 | Scion did not unite; 1 branch of stock developed. | | | | | [1] | | | | |
| 3 | do | 1 | Scion did not unite; 2 branches of stock developed. | | | | | Aug. 30 | Sept. 22 | 152 | 62 | |
| | | | | | | | | Sept. 10 | Sept. 29 | 159 | 56 | |
| 4 | do | 1 | Scion did not unite; 1 branch of stock developed. | | | | | Sept. 6 | Sept. 13 | 143 | 85 | |
| 5 | do | 1 | Scion did not unite; 2 branches of stock developed. | | | | | Sept. 10 | Sept. 22 | 152 | 68 | |
| | | | | | | | | | | 152 | 65 | |
| 6 | do | 2 | Scions united; stock failed to develop branches. | June 29 | July 8 | 76 | 45 | | | | | |
| | | | | July 8 | July 20 | 88 | 43 | | | | | |
| 7 | do | 1 | Scion united; 1 branch of stock developed. | July 12 | do | 88 | 49 | Oct. 23 | Nov. 5 | 196 | 22 | 108 |
| 8 | do | 1 | Union of scion weak; stock developed 1 branch. | Sept. 10 | Sept. 29 | 159 | 40 | Aug. 30 | Sept. 10 | 140 | 77 | −19 |
| 9 | do | 1 | Scion united; stock failed to develop branches. | June 30 | July 17 | 85 | 58 | | | | | |
| 10 | do | 1 | Scion did not unite; stock developed 2 branches. | | | | | Sept. 10 | Sept. 22 | 152 | 61 | |
| | | | | | | | | | Sept. 23 | 153 | 72 | |
| 11 | do | 1 | Scion united; stock developed 1 branch. | Sept. 10 | Sept. 22 | 152 | 55 | Sept. 22 | Sept. 29 | 159 | 63 | 7 |
| 12 | do | 1 | do | July 10 | July 20 | 88 | 44 | do | do | 159 | 58 | 71 |
| 13 | do | 1 | do | do | do | 88 | 45 | Sept. 29 | Oct. 8 | 168 | 31 | 80 |
| 14 | do | 1 | do | do | July 31 | 99 | 49 | Aug. 26 | Sept. 22 | 152 | 58 | 53 |
| 15 | Apr. 13<br>Apr. 24 | 2 | Scion grafted April 13 failed to unite; second scion cut back from 30 to 18 inches June 4; stock developed 2 branches. | | | | | Sept. 10 | do | [2] 151 | 65 | 76 |
| | | | | June 29 | July 8 | 75 | 54 | Sept. 29 | Oct. 9 | 168 | 31 | 93 |
| 16 | Apr. 23 | 1 | Scion united; stock developed 1 branch. | | June 15 | 53 | 50 | Sept. 22 | Oct. 8 | 168 | 70 | 115 |
| 17 | Mar. 16 | 1 | do | | July 8 | 114 | 53 | Sept. 10 | Sept. 22 | 190 | 70 | 76 |
| 18 | do | 1 | do | July 10 | July 20 | 126 | 44 | Sept. 20 | Sept. 29 | 197 | 83 | 71 |
| 19 | Apr. 23 | 1 | Scion united; stock kept defoliated to tip from July 24. | July 15 | July 31 | 99 | 36 | Nov. 9 | Late November | 221 | 30 | 122 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | do | 2 | Scions failed to unite; 1 branch of stock kept defoliated to tip from June 18. | | | | | | Nov. 13 | 204 | [1]51 | |
| 21 | May 11 | 1 | Scion united; stock defoliated to tip from June 18. | July 28 | Aug. 20 | 101 | 48 | (4) | (4) | | | |
| 22 [5] | | | | | | | | Sept. 10 | Sept. 22 | 152 | 95 | |
| 23 | | | | | | | | Aug. 26 | do | 152 | 92 | |
| 24 | | | | | | | | Sept. 10 | do | 152 | 100 | |
| 25 | | | | | | | | Aug. 26 | Late September | 152+ | | |
| 26 | | | | | | | | Sept. 10 | Sept. 30 | 160 | 95 | |
| 27 | | | | | | | | do | Sept. 22 | 152 | 82 | |
| 28 | | | | | | | | June 15 | June 25 | 63 | 48 | |
| 29 | | | | | | | | do | June 29 | 67 | 49 | |
| 30 | | | | | | | | do | June 25 | 63 | 50 | |
| 31 | | | | | | | | Aug. 23 | Aug. 30 | 129 | 75 | |
| 32 | | | | | | | | Sept. 10 | Sept. 16 | 146 | 86 | |
| 33 [6] | | | | | | | | do | Oct. 9 | 169 | 85 | |
| 34 | | | | | | | | Sept. 22 | Sept. 30 | 160 | 93 | |
| 35 | | | | | | | | Aug. 26 | Aug. 30 | 129 | 92 | |
| 36 | | | | | | | | do | Sept. 10 | 140 | 98 | |
| 37 | | | | | | | | Sept. 10 | Sept. 16 | 146 | 95 | |
| 38 | | | | | | | | Sept. 22 | Sept. 30 | 160 | 95 | |

[1] On Oct. 12 plant height 65 inches; no buds evident.
[3] Computed from April 24, date of grafting of scion that united.
[3] Defoliated portion 34 inches.
[4] None by Nov. 13, when plants were 22½ inches tall.
[5] Plants 22 to 32, inclusive, in 14-quart pails as controls. Flowering period computed from April 23.
[6] Plants 33 to 38 inclusive, in 32-quart DeWitt cans as controls. Flowering period computed from April 23.

In this group of 8 plants, the Connecticut Broadleaf scions began to flower through a period extending from 53 (No. 16, flowering June 15) to 152 days (No. 11, flowering September 22) from the date of grafting, whereas the branches from the Maryland Mammoth stocks of plants 11 to 18 flowered through a period extending from 151 to 197 days from the date of grafting. In these grafts the Connecticut Broadleaf scions had flowered from 7 to 115 days before the branches from the Maryland Mammoth used as the stock.

Since plants 1, 3, 4, 5, and 10 on which the Connecticut Broadleaf scions had failed to unite flowered through a period extending from 143 to 159 days, it would appear that the floriferous Connecticut Broadleaf scions on plants 11 to 18 had not hastened flowering of the Maryland Mammoth branches.

Two plants, 19 and 21, upon which scions of Connecticut Broadleaf were growing, received additional treatment. The Maryland Mammoth branches on plant 19 were kept defoliated from July 24 and those on plant 21 from June 18. The Maryland Mammoth branch of 19 showed buds in 200 days from the date of grafting but did not flower until the last week in November, about 221 days from the date of grafting. On the Maryland Mammoth branch of plant 21, which had been grafted with Connecticut Broadleaf May 11, buds had not appeared as late as November 13, 186 days from the date of grafting. The period of defoliation of plant 19 amounted to 119 days to November 20 and of plant 21 to 155 days. It is possible that defoliation actually delayed flowering in these instances, since control plants 22 to 38, which were grown either in pails or in the larger DeWitt cans and had not been grafted or given other treatments, flowered somewhat earlier, with a range of 63 to 169 days. Plant 20 was also grafted with a scion of Connecticut Broadleaf April 23, but this did not unite. One Maryland Mammoth branch on this plant was defoliated from June 18 and not until November 13, 204 days after the graft was made, or after 148 days of defoliation, did it flower. None of the controls flowered much later than 152 to 169 days after April 23, whereas the three defoliated plants (19, 20, and 21) flowered at least 200 days after that date; plant 19 was only in bud 200 days after April 23 and plant 20 flowered 204 days after that date.

A comparison of the data of tables 1 and 2 with respect to time of budding or flowering shows that there was a noticeable delay in the beds. If the time of flowering of the untreated controls in the two groups is compared, it will be seen that in most instances actual flowering in the containers occurred within about 160 days. The controls in the beds, on the other hand, had shown no buds even at the end of a period of 182 days and flowering was delayed to about 231 days in most cases.

Three plants, 28, 29, and 30, in the group of controls presented in table 2, flowered within a period of 63 to 67 days, whereas the majority of the other plants in this lot required 152 to 160 days. Abnormally early flowering in these instances is probably explainable by the fact that when cut back in the spring, after producing seed all winter, these three plants for some reason still retained enough of a residual flowering stimulus to cause seemingly premature flowering independ-

ently of the summer length of day, which was then far above the critical length and distinctly unfavorable for flowering in this short-day variety.

Data of tables 1 and 2 indicate that where grafts had been made between the short-day Maryland Mammoth variety and the day-neutral Connecticut Broadleaf, there was no hastening of flowering in the Maryland Mammoth branches as a result of transfer of some flower-producing material or stimulus from the early-flowering Connecticut Broadleaf. This negative behavior was shown whether the Maryland Mammoth was used as stock or scion. Furthermore, there was no indication that defoliation of the Maryland Mammoth branches facilitated any movement of an active flower-inducing stimulus into such branches under the conditions of these experiments. In fact, there appears to be some indication that defoliation delayed rather than hastened flowering.

## DISCUSSION AND CONCLUSIONS

Workers who have critically studied the length-of-day responses of plants are generally agreed that the flowering stimulus originates in the leaves of plants subjected to a suitable length of day favorable to flowering. Among these are Cajlachjan (*4*), Cajlachjan and Aleksandrovskaia (*5*), Fabian (*6*), Knott (*10*), Kuijper and Wiersum (*11*), Lubimenko and Bouslova (*12*), Moskov (*15*), Zimmerman and Hitchcock (*18*), Melchers (*13*), Hamner and Bonner (*8*), and Hamner and Long (*9*). Furthermore, it has been reported by Borthwick and Parker (*2*) for soybeans, by Hamner and Bonner (*8*) for cocklebur, and by Withrow et al. (*17*) for spinach that this stimulus under favorable conditions of treatment can induce flowering in the branches of a plant that has never experienced a favorable length of day. Some workers have assumed that this stimulus depends upon a diffusible flower-inducing substance that has formed in response to a particular photoperiod.

The data obtained in the localization and defoliation tests with the Maryland Mammoth plants are in agreement with those obtained when an early-flowering variety, Connecticut Broadleaf, was grafted with the short-day, late-flowering Maryland Mammoth variety (tables 1 and 2). In no instance was it indicated that any flowering stimulus was imparted to Maryland Mammoth branches experiencing a length of day above that critical for flowering, either from the Connecticut Broadleaf branches in grafts or from branches that were given short-day conditions favorable to flowering.

In the light of the differences in behavior that have been reported by various workers with other species, both short-day and long-day types, the results reported in the present paper do not appear unusual.

Borthwick and Parker (*2*) reported that when one branch of a two-branched Biloxi soybean plant was subjected to short photoperiods favorable to flowering at the same time that another was subjected to long photoperiods above the critical for flowering, the initiation of flower buds did not extend to the receptor branch until this had been defoliated. The presence of leaves upon the receptors appeared to

keep the flowering impulse localized upon the donors. Borthwick and Parker also showed that the flowering impulse arises in the leaves.

Hamner and Bonner (*8*) showed that cocklebur (*Xanthium pensylvanicum*) departs somewhat from this behavior. If one branch of a two-branched plant of cocklebur is exposed to a photoperiod favorable to flowering, the receptor branch experiencing long photoperiods above the critical for flowering will also flower even though it has not been defoliated. Hamner and Bonner showed that the stimulus responsible for flowering originates in the leaves of the cocklebur and that one leaf given short photoperiods is sufficient to cause the initiation of flower buds in other portions of the plant subjected to photoperiods too long to induce flowering. Similar results reported by Borthwick and Parker (*3*), working with Biloxi soybeans, also showed that individual leaves given the proper photoperiod can induce floral initiation.

Withrow et al. (*17*), working with Nobel spinach, a plant flowering in response to long days, reported that when the leaves of a plant received long photoperiods favorable to flowering while the rest of the plant experienced short photoperiods unfavorable to flowering flower buds were initiated in the long-day portion. One leaf subjected to long photoperiods was not enough to induce flower primordia to form in a normal intact plant exposed to short photoperiods. However, if the rest of the plant was defoliated, one leaf was sufficient, showing that in the case of spinach the leaves in an unfavorable photoperiod exercised an inhibiting effect.

Moskov (*16*) grafted scions of *Nicotiana rustica* and *N. tabacum* var. Samsun on Maryland Mammoth stocks subjected to continuous light unfavorable to flowering. In the case of Samsun two methods of grafting, the cleft graft and the splice graft, were used; in the latter, scions were fitted and bound to branches of the stock on a single slanting cut. Moskov stated that the early-flowering scions, both *N. rustica* and Samsun, hastened flowering in side branches of the Maryland Mammoth but that Samsun had this effect only when the splice graft was used.

Melchers (*14*) grafted annual forms of *Hyoscyamus niger* L. with biennial forms and asserted that there was a change from the biennial vegetative habit to the annual flowering habit in the growing points. He stated that flowering scions of *H. albus* when grafted with the biennial *H. niger* induced the growing point of the latter to become flowering in its expression and that scions of the short-day Maryland Mammoth plant under short-day conditions also caused flower formation on stocks of the biennial *Hyoscyamus*. He failed to change the vegetative development of the growing point of this biennial stock when he used scions of tomato, however, but this he thought might have been due to a poor union of the graft.

The evidence presented under the conditions of the writer's experiments is somewhat at variance with some of these results. It is obvious that the uniformity of behavior shown in these tests with tobacco is not an accidental one. It is significant that *Xanthium* (*8*) did not behave in the same manner as Biloxi soybean (*2*), since the receptor in the case of *Xanthium* flowered without defoliation. The

Maryland Mammoth tobacco in the tests presented did not flower whether or not the receptor was defoliated.

When grafts are made between types of tobacco as different in their flowering behavior as the day-neutral Connecticut Broadleaf and the short-day Maryland Mammoth, the resultant combination becomes somewhat unbalanced or unstabilized. Often it is very hard to maintain an equilibrium of growth in the branches of scion and stock and so prevent one or more branches from becoming completely dominant and perhaps severely disturbing growth conditions in other branches. It would appear that the Maryland Mammoth branch under some conditions may become so vigorous and dominant as to direct to itself nearly all growth material formed by the plant and thus leave the Connecticut Broadleaf branch impoverished and stunted. It can be readily theorized that this may profoundly affect the flowering behavior of either branch and, consequently, hasten or delay flowering in one or another member if an actual flower-forming, transportable hormone is involved.

It would appear that results of work up to the present time indicate considerable variability in the behavior of different plants with respect to the effects of localization of photoperiods favorable to flowering and the transmission of the effects to other parts of a plant experiencing unfavorable photoperiods. While it is generally held that the stimulus for flowering originates in the leaf, there is no good reason why this should necessarily be so. The leaf itself is a complex assimilative organ, and in the case of tobacco it is sessile in its attachment, with large auricles extending around the stem or more or less decurrent upon it.

The petiole of the leaf, the leaf blade, and the large auricles contain an abundance of green pigment. The main stem and branches of the plant are also green and would appear to be capable of photosynthetic assimilation. It is for this reason that some of the plants (for example, plant 3, table 1) were not only defoliated but wrapped with light-impervious black cloth up to the apex of the branch. This treatment, however, as previously stated, did not appear to hasten flowering in the defoliated Maryland Mammoth branch.

Cycles of various alternations of light and darkness are of direct import in these studies. Hamner and Bonner (*8*), as a result of their studies of *Xanthium*, concluded that the dark period is more responsible than the light one for flowering in response to favorable photoperiods. They concluded further that, in any cycle of alternations of light and darkness, a dark period in excess of 8½ hours should cause flowering and, conversely, that any dark period shorter than 8½ hours should prevent flowering. While this may be true for the behavior of *Xanthium*, it is not true, as Allard and Garner (*1*) have shown, for some other plants.

Allard and Garner (*1*), working with Peking soybeans and other plants, showed that not only the ratio but also the absolute cycle within which the ratio is operative profoundly affected growth and reproduction. No conclusions could be drawn relative to a particular length of either the light or the dark period. Here again the behavior of *Xanthium* does not appear to be entirely comparable with that of the

Peking soybean or other plants. *Xanthium*, however, seems to be a typical example of a short-day plant with a very narrow critical photoperiod for flowering, since a difference of 15 minutes, according to Hamner and Bonner (*8*), may determine whether flowering will occur.

## SUMMARY

In localization tests on plants of Maryland Mammoth tobacco, lightproof cases were used to darken the leaves or branches, subjecting these to short photoperiods favorable to flowering. In one test the outside branch was kept defoliated. There was no indication of hastened flowering in any of these tests. It is possible that the tests were begun too late in the season for positive results, as indicated by a test during a second year.

Many grafts were made between the short-day Maryland Mammoth variety of tobacco and the day-neutral Connecticut Broadleaf variety, both being used as either stock or scion. Some of the Maryland Mammoth branches were kept defoliated for many weeks and one was both defoliated and wrapped with light-impervious black cloth to determine whether such branches would flower earlier than untreated branches in similar grafts. There was no indication of transmission of a flowering stimulus from the flowering Connecticut Broadleaf stems (donors) to the defoliated or darkened Maryland Mammoth stems (receptors). In most instances there appeared to be delayed flowering in these treated stems.

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